## **CLAIMS**

## What is claimed is:

- 1. A composite comprising
  - a porous carbon structure comprising a surface and pores; and
  - a coating on the surface comprising an electroactive polymer;
    wherein the coating does not completely fill or obstruct a majority of the pores.
- 2. The composite of claim 1, wherein the structure is a carbon aerogel.
- 3. The composite of claim 1, wherein the structure is selected from the group consisting of carbon nanofoam and templated mesoporous carbon.
- 4. The composite of claim 1, wherein the pores have an average diameter of from about 2 nm to about 1 μm.
- 5. The composite of claim 1, wherein the polymer is a conductive polymer.
- 6. The composite of claim 1, wherein the polymer is a polyaniline or derivative thereof.
- 7. The composite of claim 1, wherein the polymer is selected from group consisting of a redox polymer, a polyarylamine, a polypyrrole, polyacetylene, a polythiophene, and derivatives thereof.
- 8. The composite of claim 1, wherein the coating has a thickness of no more than about 10 nm.
- 9. The composite of claim 1, wherein the coating is formed by self-limiting electropolymerization.

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10. A capacitor comprising an anode, a cathode, and an electrolyte, wherein the anode, the cathode, or both comprise:

a composite comprising

a porous carbon structure comprising a surface and pores; and
a coating on the surface comprising an electroactive polymer;
wherein the coating does not completely fill or obstruct a majority of the
pores; and

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a current collector in electrical contact with the composite.

- 11. The capacitor of claim 10, wherein the structure is a carbon aerogel.
- 12. The capacitor of claim 10, wherein the structure is selected from the group consisting of carbon nanofoam and templated mesoporous carbon.
- 13. The capacitor of claim 10, wherein the pores have an average diameter of from about 2 nm to about 1 μm.
- 14. The capacitor of claim 10, wherein the polymer is a conductive polymer.
- 15. The capacitor of claim 10, wherein the polymer is a polyaniline or derivative thereof.
- 16. The capacitor of claim 10, wherein the polymer is selected from group consisting of a redox polymer, a polyarylamine, a polypyrrole, polyacetylene, a polythiophene, and derivatives thereof.
- 17. The capacitor of claim 10, wherein the coating has a thickness of no more than about 10 nm.
- 18. The capacitor of claim 10, wherein the coating is formed by self-limiting electropolymerization.
- 19. The capacitor of claim 10, wherein the electrolyte comprises sulfuric acid.

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20. The capacitor of claim 10, wherein the electrolyte comprises a liquid selected from the group consisting of an aqueous acid and a protonic ionic liquid.

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- 21. A method of forming a composite comprising the steps of: providing porous carbon structure comprising a surface and pores; infiltrating the structure with a monomer which can form an electroactive polymer; and electropolymerizing the monomer forming a coating on the surface comprising the electroactive polymer without completely filling or obstructing a majority of the pores.
- 22. The method of claim 21, wherein the structure is a carbon aerogel.
- 23. The method of claim 21, wherein the structure is selected from the group consisting of carbon nanofoam and templated mesoporous carbon.
- 24. The method of claim 21, wherein the pores have an average diameter of from about 2 nm to about 1  $\mu$ m.
- 25. The method of claim 21, wherein the polymer is a conductive polymer.
- 26. The method of claim 21, wherein the polymer is a polyaniline or derivative thereof.
- 27. The method of claim 21, wherein the polymer is selected from group consisting of a redox polymer, a polyarylamine, a polypyrrole, polyacetylene, a polythiophene, and derivatives thereof.
- 28. The method of claim 21, wherein the electropolymerization step comprises self-limiting electropolymerization.
- 29. The method of claim 21, wherein the coating has a thickness of no more than about 10 nm.

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- 30. The method of claim 21, wherein the infiltrating step comprises immersing the structure in a solution of the monomer.
- 31. A method of storing charge comprising the steps of:

  providing a capacitor comprising an anode, a cathode, and an electrolyte, wherein the anode,
  the cathode, or both comprise:

a composite comprising

a porous carbon structure comprising a surface and pores; and
a coating on the surface comprising an electroactive polymer;
wherein the coating does not completely fill or obstruct a majority of
the pores; and

a current collector in electrical contact with the composite; and charging the capacitor.

- 32. The method of claim 31, wherein the structure is a carbon aerogel.
- 33. The method of claim 31, wherein the structure is selected from the group consisting of carbon nanofoam and templated carbon.
- 34. The method of claim 31, wherein the pores have an average diameter of from about 2 nm to about 1  $\mu$ m.
- 35. The method of claim 31, wherein the polymer is a conductive polymer.
- 36. The method of claim 31, wherein the polymer is a polyaniline or derivative thereof.
- 37. The method of claim 31, wherein the polymer is selected from group consisting of a redox polymer, a polyarylamine, a polypyrrole, polyacetylene a polythiophene, and derivatives thereof.
- 38. The method of claim 31, wherein the coating has a thickness of no more than about 10 nm.

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39. The method of claim 31, wherein the coating is formed by self-limiting electropolymerization.

- 40. The method of claim 31, wherein the electrolyte comprises sulfuric acid.
- 41. The method of claim 31, wherein the electrolyte comprises a liquid selected from the group consisting of an aqueous acid and a protonic ionic liquid.

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